IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BOARD OF PATENT APPEALS AND INTERFERENCES

In re Patent Application of: Vijayavel Bagavath-Singh

Application No.: 10/525,938 | Confirmation No.: 4878

Filed: February 25, 2005 | Art Unit: 3742

For: PART-GEOMETRY INDEPENDENT REAL TIME CLOSED LOOP WELD POOL TEMPERATURE CONTROL SYSTEM FOR MULTI-LAYER DMD PROCESS | Examiner: T. S. Tran

APPELLANT'S APPEAL BRIEF UNDER 37 C.F.R. §41.37

Mail Stop APPEAL BRIEF
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

I. Real Party in Interest

The real party in interest in this case is The P.O.M. Group, by assignment.

II. Related Appeals and Interferences

There are no appeals or interferences which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

III. Status of Claims

The present application was filed with 13 claims. Claims 1-13 are pending, rejected and under appeal. Claim 1, 8 and 12 are the independent claims.

IV. Status of Amendments

No after-final amendments have been filed.

V. Summary of Claimed Subject Matter

Independent claim 1 is directed to a method of forming a metal section on a metal substrate by depositing a plurality of superimposed layers using a laser generating a heating beam and a powdered metal source operative to feed metal powder into the beam and moving the substrate relative to the beam under numerical control over a programmed path to provide an advancing melt pool. (Specification, page 6, line 20 to page 8, line 10) The method comprises the step of sensing parameters of the melt pool at a plurality of selected coordinates during the generation of a plurality of metallic layers (Specification, page 8, line 11 to page 10, line 9) The sensed parameters of the pool at each of the selected coordinates are stored (Specification, page 10, lines 10 to 22) The stored parameters are processed to determine an appropriate laser power for use during the deposition of a subsequent layer. (Specification, page 11, line 1 to page 12, line 7)

Independent claim 8 is directed to method of forming a metal section on a metal substrate by depositing a plurality of superimposed layers by using a power source generating a heating beam and a metal source operative to feed metal powder into the beam and moving the substrate relative to the beam over the section to provide an advancing melting pool (Specification, page 6, line 20 to page 8, line 10) The method comprises sensing parameters of the melt pool at a plurality of selected coordinates during the generation of a plurality of metallic layers (Specification, page 8, line 11 to page 10, line 9); storing the sensed parameters of the pool at each of the coordinates (Specification, page 10, lines 10 to 22); and processing the stored parameters to determine an appropriate laser power for use during deposition of a subsequent layer. (Specification, page 11, line 1 to page 12, line 7)

Independent claim 12 is directed to a method of forming a metal section on a metal substrate by depositing a plurality of superimposed layers using a heating beam and a powdered metal source operative to feed metal powder into the beam and moving the substrate relative to the beam under numerical control over a programmed path to provide an advancing melting pool (Specification, page 6, line 20 to page 8, line 10) The method comprises depositing a first layer in contact with the substrate using a first heating beam power; depositing a second layer over the first layer using the same heating beam power as used in the first layer and sensing parameters of the melt pool at a plurality of selected coordinates during the generation of said second layer; depositing a third layer using the same heating beam power as employed in the first two layers and sensing parameters of

the melt pool at said selected coordinates during generation of the third layer; and using the stored parameters of the melt pool during generation of the second and third layers to determine an appropriate heating beam power for use during deposition of subsequent layers. (Specification, page 10, line 10 to page 12, line 2; *See*, Figures 3, 4)

VI. Grounds of Rejection To Be Reviewed On Appeal

A. The rejection of claim 1 under 35 U.S.C. §103(a) as being unpatentable over U.S. Publication No. 2004/0251242 to Suh in view of U.S. Patent No. 5,715,375 to Ito.

B. The rejection of claim 2 under 35 U.S.C. §103(a) as being unpatentable over U.S. Publication No. 2004/0251242 to Suh in view of U.S. Patent No. 5,715,375 to Ito.

C. The rejection of claim 3 under 35 U.S.C. §103(a) as being unpatentable over U.S. Publication No. 2004/0251242 to Suh in view of U.S. Patent No. 5,715,375 to Ito.

D. The rejection of claim 4 under 35 U.S.C. §103(a) as being unpatentable over U.S. Publication No. 2004/0251242 to Suh in view of U.S. Patent No. 5,715,375 to Ito.

E. The rejection of claim 5 under 35 U.S.C. §103(a) as being unpatentable over U.S. Publication No. 2004/0251242 to Suh in view of U.S. Patent No. 5,715,375 to Ito, and further in view of U.S. Patent No. 5,681,490 to Chang.

F. The rejection of claim 6 under 35 U.S.C. §103(a) as being unpatentable over U.S. Publication No. 2004/0251242 to Suh in view of U.S. Patent No. 5,715,375 to Ito, and further in view of U.S. Patent No. 5,681,490 to Chang.

G. The rejection of claim 7 under 35 U.S.C. §103(a) as being unpatentable over U.S. Publication No. 2004/0251242 to Suh in view of U.S. Patent No. 5,715,375 to Ito, and further in view of U.S. Patent No. 5,681,490 to Chang.

H. The rejection of claim 8 under 35 U.S.C. §103(a) as being unpatentable over U.S. Publication No. 2004/0251242 to Suh in view of U.S. Patent No. 5,715,375 to Ito.

I. The rejection of claim 9 under 35 U.S.C. §103(a) as being unpatentable over U.S. Publication No. 2004/0251242 to Suh in view of U.S. Patent No. 5,715,375 to Ito.

J. The rejection of claim 10 under 35 U.S.C. §103(a) as being unpatentable over U.S. Publication No. 2004/0251242 to Suh in view of U.S. Patent No. 5,715,375 to Ito, and further in view of U.S. Patent No. 3,991,930 to Ekerot.

K. The rejection of claim 11 under 35 U.S.C. §103(a) as being unpatentable over U.S. Publication No. 2004/0251242 to Suh in view of U.S. Patent No. 5,715,375 to Ito, and further in view of U.S. Patent No. 5,427,733 to Benda.

L. The rejection of claim 12 under 35 U.S.C. §103(a) as being unpatentable over U.S. Publication No. 2004/0251242 to Suh in view of U.S. Patent No. 5,715,375 to Ito, and further in view of U.S. Patent No. 5,427,733 to Benda.

M. The rejection of claim 13 under 35 U.S.C. §103(a) as being unpatentable over U.S. Publication No. 2004/0251242 to Suh in view of U.S. Patent No. 5,715,375 to Ito, and further in view of U.S. Patent No. 5,427,733 to Benda.

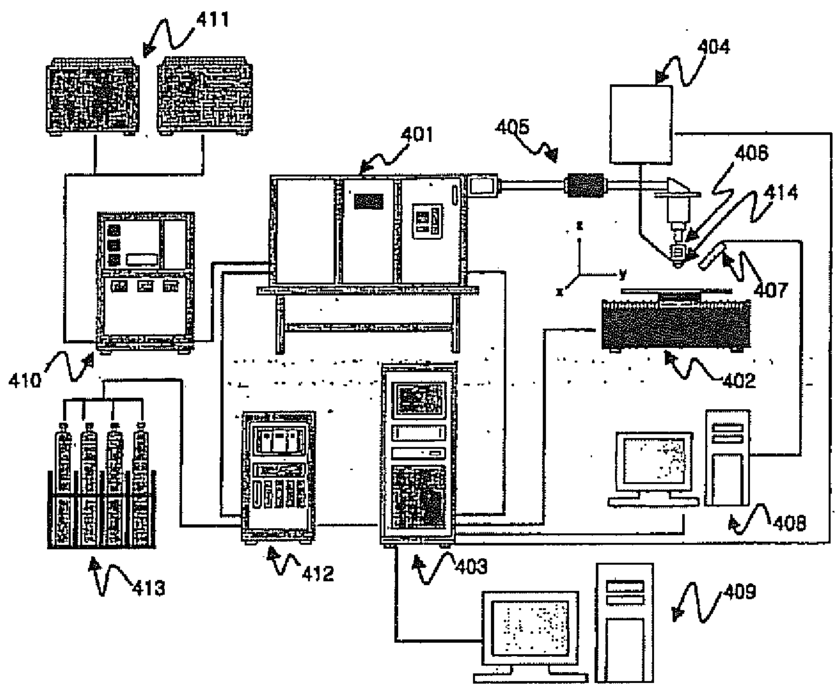
VII. Argument

A. The Rejection of Claim 1.

Claims 1 stands rejected under 35 USC §103 over Suh in view of Ito. Suh resides in laser cladding and direct metal manufacturing and, in particular, to a method of real-time monitoring and controlling the height of a cladding layer using image photographing and image processing technology (Suh, [0001]). The height is controlled by monitoring the position and the height of a melt pool and controlling as the intensity of laser power, a parameter which Suh considers to be one of the most important process variables (Suh, Abstract]).

The essence of Suh is set forth at [0083]:

> "The control system 403 [see Fig. 4 of Suh, below] receives data on the height of the molten pool from the image processing apparatus 408 every 20 msec, compares the data with shaping information transmitted from the CAD/CAM apparatus 409, and determines a laser power value required to allow the height of the molten pool to reach a target value. The value determined as described-above is digital data so the value is converted into an analog signal through a D/A converter and inputted to the laser generator 401."



It is apparent from this section of Suh, and the disclosure of Suh overall, that Suh stores no information from previous layers for use in subsequent layers. Rather, the sole, disclosed purpose of Suh is to speed up feedback during the generation of a given melt pool, then move on *with no memory of what occurred previously*. Indeed, the very fact that Suh is directed to real-time control proves that previously stored parameters cannot be used.

Even in the final rejection, the Examiner acknowledges that "Suh does not teach storing the sensed parameters." (Final OA, ¶4, top of page 3) Then the Examiner proceeds to argue that Suh teaches "processing the stored parameters to determine an appropriate laser power for use during the deposition of a subsequent layer." (OA, page 3, ¶4) This is inconsistent since if Suh does not *store* parameters, he cannot *process* them [the stored parameters].

The Examiner submits that Suh discloses "processing" at Fig. 4, item 403 and Pg 4, 0054. This is true. Fig. 4, item 403 is a control system, and [0054] states that "the control system 403 serves to perform a laser cladding operation on the basis of shaping information received from the CAD/CAM apparatus 409 and control in real time cladding process parameters to allow the height of a cladding layer to reach a target value on the basis of information on the height of a molten pool received from the image processing apparatus 408. Alternatively, the control system may be comprised of a general numeric control system in place of the PC-NC system." Thus, Suh shows "a

processor," but does not teach "processing stored parameters to determine an appropriate laser power for use during the deposition of a subsequent layer."

In fact, the Examiner's references to "subsequent layers" in relation to Suh are erroneous. The Examiner argues that Suh teaches processing the stored parameters to determine an appropriate laser power "for use during the deposition of a subsequent layer" in the Abstract of Suh, lines 5-15 (Final OA, top of page 3), which read as follows:

> "This invention also provides a method of controlling the intensity of laser power, which is one of the most important process variables, regardless of the operational condition of a laser power unit (401). The method and system of this invention controls the height of a deposit (205) by real-time monitoring the position and the height of a melt pool (203) and controlling the process variables using the image photographing and image processing technology in such a laser cladding and laser-aided direct metal manufacturing process based on a laser surface modification technology, such as laser surface alloying..."

As can be seen from the passage cited by the Examiner, no mention is made of any "subsequent layers." In fact, Suh makes it clear that "[t]he method and system of this invention controls the height of ***a*** deposit (205) by real-time monitoring the position and the height of ***a*** melt pool ... based on ***a*** laser surface modification technology..." The fact that Suh refers only to a *single* deposit associated with a *single* melt pool to modify a *single* surface makes it clear that subsequent layers are irrelevant.

Appellant's invention, on the other hand, solves the problem of substrate ***heat build-up*** during direct-metal deposition.

> "In particular, FIG. 2 [reproduced below] illustrates a typical workpiece generally indicated at 32, which includes an underlying metallic substrate 34 with a DMD deposited section 36 formed by a plurality of layers on its upper surface. As the initial layers of the deposited volume 36 are formed, much of the thermal energy of the laser goes to heating the underlying metallic substrate 34. As the deposition continues, the substrate reaches a maximum temperature and thereafter additional laser power goes to melting the powdered metal in previously deposited areas. If constant laser power were applied to each area, the weld pool size would begin to grow as the substrate 34 heats up producing an irregular deposition pattern. The present invention compensates for this phenomenon."

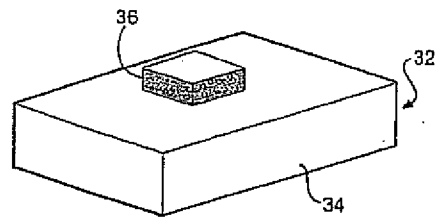


FIG - 2

In compensating for this phenomenon, stored parameters form previous layers *must be* used to control deposition during subsequent layers. Suh does not consider such a method or system for carrying this out. Nor does Suh teach or suggest other limitations, such as the "sensing parameters of the melt pool at a plurality of selected coordinates during the generation of a plurality of metallic layers." It is Appellant's position that to the extent that Suh even senses at a plurality of selected coordinates, it is certainly not done "during the generation of a plurality of metallic layers" for later storage and retrieval.

Nevertheless, the Examiner argues that it would be obvious to combine Suh with Ito (with respect to claims 1-4, 8 and 9) "for the benefit of processing the image information by the image processor." (OA, page 3, ¶6) Appellant does not understand this *rationale*. Suh already "processes" the "image information by the image processor." This is entirely unrelated to Appellant's claimed steps of:

> sensing parameters of the melt pool at a plurality of selected coordinates during the generation of a plurality of metallic layers;
>
> storing the sensed parameters of the pool at each of the selected coordinates; and
>
> processing the stored parameters to determine an appropriate laser power for use during the deposition of a subsequent layer.

The Examiner "interprets that the pixels of Suh are equivalent to the Appellant's plurality of selected coordinates because pixels of Suh represent the plurality of coordinates that make up the height of the weld pool." (Final OA, middle of page 3). This interpretation is only partially correct and is out of context. According to Suh, "the control system 403 [*see* figure, above] receives data on the height of the molten pool from the image processing apparatus 408 every 20 msec, compares the data with shaping information transmitted from the CAD/CAM apparatus 409, and determines a

laser power value required to allow the height of the molten pool to reach a target value." (Suh, [0083]) Thus while a pixel is representative of height, that height is compared only to a "target value" associated with shaping information transmitted from the CAD/CAM apparatus. Appellant disclosed this basic principle years ago (see U.S. Patent No. 6,122,564). The idea of sensing parameters of the melt pool at a plurality of selected coordinates; storing the sensed parameters; and using the stored parameters to determine an appropriate laser power for use *during the deposition of a subsequent layer* is new.

The Examiner's Response to Arguments is equally unavailing. The Examiner argues that "[i]t is inherent in laser cladding and laser-aided direct metal manufacturing process that information about the previous layer will be stored to be used in the subsequent layers to be able to correctly build the 3D object." (Final OA, middle of page 11). The Examiner is incorrect; storing information about a previous layer to deposit a subsequent layer is not inherent, and only Appellants found that this helps to "correctly" build a 3D object due to substrate heat build-up. The Examiner's only real argument is that Suh shows a computer (Fig. 4, Item 403) and "the computer has a memory to store the information." It doesn't necessarily follow that Suh duos store such information and there is no evidence whatsoever in Suh that such information is desired, needed or used. For at least this reason, Suh would not benefit from the teachings of Ito, and *prima facie* obviousness has not been established.

For the sake of completeness, Appellants would like to point out that Ito also does not disclose processing stored parameters to determine an appropriate laser power for use during the deposition of a subsequent layer. The Examiner cites 5:21-26 of Ito, which reads as follows:

> "An image signal picked up by the CCD camera C is converted into a gradation signal based on a gray scale by means of the general-purpose interface 15, and is stored in the frame memory 16. Image information read from the frame memory 16 is processed by the image processor 17."

This has nothing to do with sensing parameters of the melt pool at a plurality of selected coordinates, storing the sensed parameters of the pool at each of the selected coordinates, or processing the stored parameters to determine an appropriate laser power for use during the deposition of a subsequent layer.

B. The Rejection of Claim 2.

The Examiner's *rationale* for combining the listed references and rejecting this claim is "to provide a control system for executing multi-layer welding." This reason is unrelated to Appellant's claim limitations and forms an insufficient basis for establishing *prima facie* obviousness. Claim 2 adds to claim 1 that processing the stored parameters comprises comparing a matrix of the sensed parameters stored during formation of the last layer deposited with the matrix of the sensed parameters of an earlier deposited layer to determine an appropriate laser power for use during the deposition of the next layer. This is unrelated to "a control system for executing multi-layer welding, which could be provided for any number of reasons, not requiring Suh in view of Ito.

C. The Rejection of Claim 3.

The Examiner's *rationale* for combining the listed references and rejecting this claim is "to gradually increase the height of the resulting weld layer." Claim 3 adds to claim 2 that the earlier deposited layer constitutes the second layer deposited over the substrate. The Examiner's reason for combining Suh and Ito is unrelated to Appellant's claim limitations and forms an insufficient basis for establishing *prima facie* obviousness.

D. The Rejection of Claim 4.

The Examiner has not provided any reasons for combining the listed references.

E. The Rejection of Claim 5.

The Examiner's *rationale* for combining the listed references and rejecting this claim is "to determine the progressive stages of the laser process and the expected weld quality." This reason is unrelated to Appellant's claim limitations and forms an insufficient basis for establishing *prima facie* obviousness. Claim 5 adds to claim 1 that the sensed parameters of the pool comprise the optical intensity of the pool.

F. The Rejection of Claim 6.

The Examiner's *rationale* for combining the listed references and rejecting this claim is "to determine the progressive stages of the laser process and the expected weld quality." Claim 6 adds to claim 1 that the sensed parameters of the pool comprise the dimensions of the pool and the optical intensity of the pool. This has nothing to do with the progressive stages of a laser process or expected weld quality.

G. The Rejection of Claim 7.

The Examiner's *rationale* for combining the listed references and rejecting this claim is "to determine the progressive stages of the laser process and the expected weld quality." This reason is unrelated to Appellant's claim limitations and forms an insufficient basis for establishing *prima facie* obviousness.

H. The Rejection of Claim 8.

The Examiner's reason for combining the listed references and rejecting this claim is the same as for claim 7 even though the claims are different. In any case, the reason is unrelated to Appellant's claim limitations and forms an insufficient basis for establishing *prima facie* obviousness

I. The Rejection of Claim 9.

The Examiner has not provided any reasons for combining the listed references.

J. The Rejection of Claim 10.

The Examiner's *rationale* for combining the listed references and rejecting this claim is "to weld a multi-layer metal strip." This reason is unrelated to Appellant's claim limitations and forms an insufficient basis for establishing *prima facie* obviousness. Claim 10 adds to claim 8 that the power source is an electron beam. An electron bean is not required to weld a multi-layer metal strip.

K. The Rejection of Claim 11.

The Examiner's *rationale* for combining the listed references and rejecting this claim is "to cause the particles of powder to fuse together in the heating region." This reason is unrelated to Appellant's claim limitations and forms an insufficient basis for establishing *prima facie* obviousness. Claim 11 adds to claim 8 that the power beam level is maintained at a constant during generation of each layer. Fusing particles of powder together in a heating region can be accomplished with numerous additive manufacturing processes.

L. The Rejection of Claim 12.

Independent claim 12 is directed to a method of forming a metal section on a metal substrate by depositing a plurality of superimposed layers. This claim includes the steps of depositing first, second and third layers, and using the stored parameters of the melt pool during generation of the second and third layers to determine an appropriate heating beam power. This claim stands rejected under 35 U.S.C. §103(a) over Suh in view of Ito, and further in view of U.S. Patent No. 5,427,733 to Benda. The Examiner's reason for combining the listed references and rejecting this claim is "to process the image information by the image processor." This reason is unrelated to Appellant's claim limitations and forms an insufficient basis for establishing *prima facie* obviousness. Suh in view of Ito, and further in view of Benda do not read on using stored parameters of a melt pool during the generation of the second and third layers to determine an appropriate heating beam power. "To process the image information by the image processor" is unrelated to Appellants' claimed limitations.

M. The Rejection of Claim 13.

Claim 13 adds to claim 12 that as each subsequent layer is deposited, the parameters of the melt pool are sensed at said plurality of selected coordinates and are used, along with previously stored sensed parameters, to determine the heating beam power for subsequent layers. The Examiner's reason for rejecting this claim is the same as that used to reject claim 12; namely, "for the benefit of processing the image information by the image processor." However, reason is unrelated to Appellant's claim limitations and forms an insufficient basis for establishing *prima facie* obviousness.

Conclusion

In conclusion, for the arguments of record and the reasons set forth above, all pending claims of the subject application continue to be in condition for allowance and Appellant seeks the Board's concurrence at this time.

Respectfully submitted,

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Date: Nov. 29, 2010

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APPENDIX A

CLAIMS ON APPEAL

1. A method of forming a metal section on a metal substrate by depositing a plurality of superimposed layers using a laser generating a heating beam and a powdered metal source operative to feed metal powder into the beam and moving the substrate relative to the beam under numerical control over a programmed path to provide an advancing melt pool, comprising:

sensing parameters of the melt pool at a plurality of selected coordinates during the generation of a plurality of metallic layers;

storing the sensed parameters of the pool at each of the selected coordinates; and

processing the stored parameters to determine an appropriate laser power for use during the deposition of a subsequent layer.

2. The method of claim 1 wherein processing the stored parameters comprises comparing a matrix of the sensed parameters stored during formation of the last layer deposited with the matrix of the sensed parameters of an earlier deposited layer to determine an appropriate laser power for use during the deposition of the next layer.

3. The method of claim 2 wherein the earlier deposited layer constitutes the second layer deposited over the substrate.

4. The method of claim 1 wherein the sensed parameters of the pool comprise the dimensions of the pool.

5. The method of claim 1 wherein the sensed parameters of the pool comprise the optical intensity of the pool.

6. The method of claim 1 wherein the sensed parameters of the pool comprise the dimensions of the pool and the optical intensity of the pool.

7. The method of claim 1 wherein the sensed parameters of the melt pool comprise the temperature of the melt pool.

8. A method of forming a metal section on a metal substrate by depositing a plurality of superimposed layers by using a power source generating a heating beam and a metal source operative to feed metal powder into the beam and moving the substrate relative to the beam over the section to provide an advancing melting pool, comprising:

sensing parameters of the melt pool at a plurality of selected coordinates during the generation of a plurality of metallic layers;

storing the sensed parameters of the pool at each of the coordinates; and

processing the stored parameters to determine an appropriate laser power for use during deposition of a subsequent layer.

9. The method of claim 8 wherein the power source is a laser.

10. The method of claim 8 wherein the power source is an electron beam.

11. The method of claim 8 wherein the power beam level is maintained at a constant during generation of each layer.

12. A method of forming a metal section on a metal substrate by depositing a plurality of superimposed layers using a heating beam and a powdered metal source operative to feed metal powder into the beam and moving the substrate relative to the beam under numerical control over a programmed path to provide an advancing melting pool, comprising:

depositing a first layer in contact with the substrate using a first heating beam power;

depositing a second layer over the first layer using the same heating beam power as used in the first layer and sensing parameters of the melt pool at a plurality of selected coordinates during the generation of said second layer;

depositing a third layer using the same heating beam power as employed in the first two layers and sensing parameters of the melt pool at said selected coordinates during generation of the third layer; and

using the stored parameters of the melt pool during generation of the second and third layers to determine an appropriate heating beam power for use during deposition of subsequent layers.

13. The method of claim 12 where as each subsequent layer is deposited, the parameters of the melt pool are sensed at said plurality of selected coordinates and are used, along with previously stored sensed parameters, to determine the heating beam power for subsequent layers.

APPENDIX B

EVIDENCE

None.

APPENDIX C

RELATED PROCEEDINGS

None.